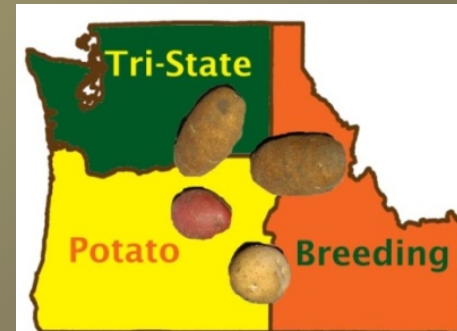


Update on the National Fry Processing Trial (NFPT) and SCRI Acrylamide Reduction Project



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Impetus for NFPT: Acrylamide

Background

- ✓ Identified as neurotoxin & carcinogen in rodents
- ✓ Suspected carcinogen in humans
- ✓ 2002: Acrylamide found in carbohydrate rich foods processed at higher temperatures

Potato Processing Industry:
Support for establishing the
NFPT in 2011

Formation

- ✓ High Heat
- ✓ Reducing Sugars

**FDA Draft Guidance for
Industry: Reducing
acrylamide in certain
foods, Nov. 2013:**

**“Development and
commercialization of new
potato varieties is a
lengthy process, but may
ultimately provide the
most effective solution for
acrylamide reduction.”**

National Fry Processing Trial

Objectives:

- ✓ Assess and identify low acrylamide breeding clones/varieties
- ✓ Suitable for fry and other processed potato products
- ✓ Acceptable agronomic and consumer attribute (CA) characteristics for adoption by processing industry

Trial Entries:

- ✓ US potato breeding programs
- ✓ Represent processing class
- ✓ Newly released varieties and advanced breeding clones
- ✓ Resistant to cold-induced sweetening (<45° F)
- ✓ Ability to store long-term



U.S. National Fry Processing Trial

Coordinated Effort

- ✓ Processors
- ✓ USPB / NPC
- ✓ Growers
- ✓ State Commissions
- ✓ QSR/Retail
- ✓ Potato Scientists

Acrylamide Reduction: Project: 2011

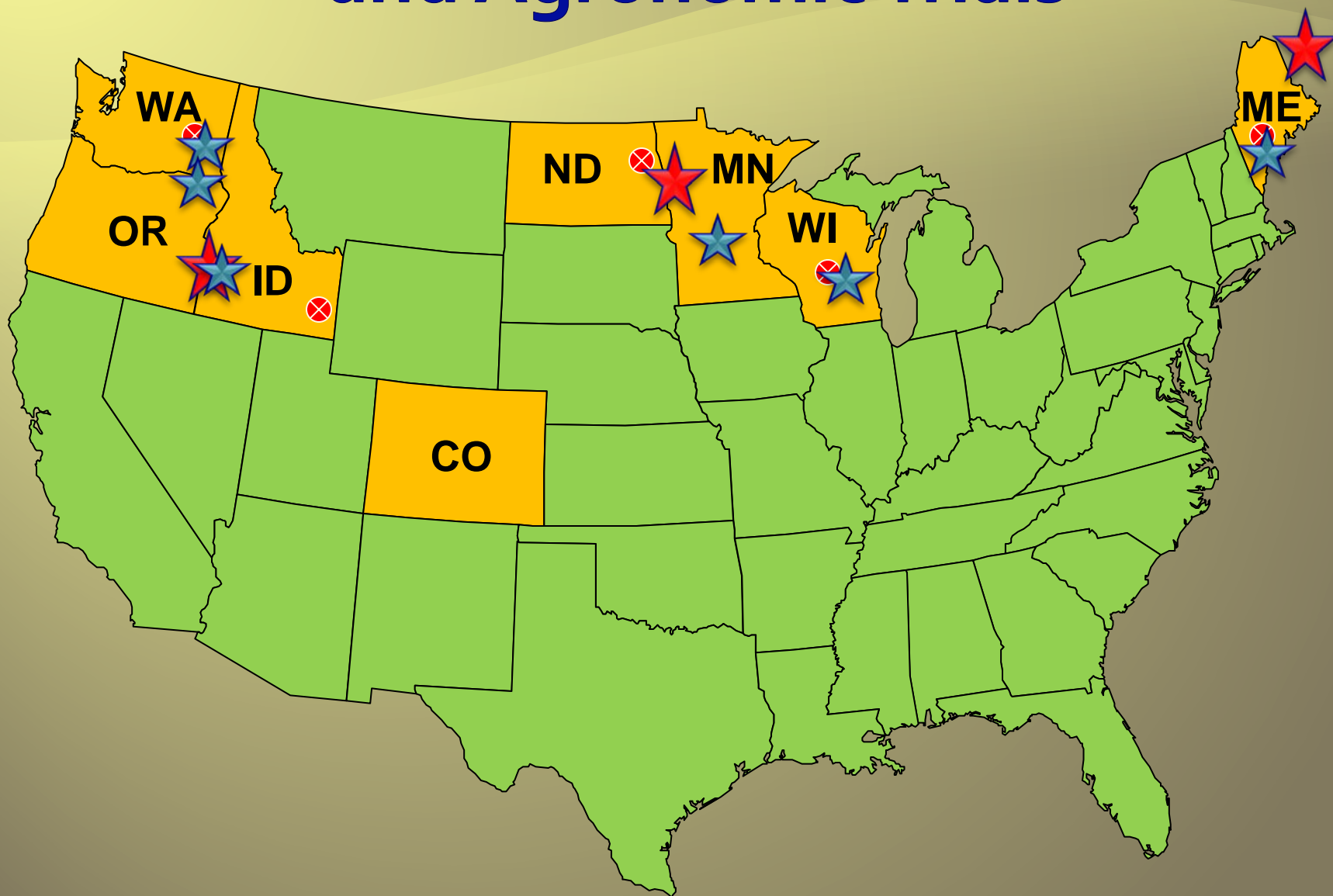
- Specialty Crop Research Initiative
- \$7.8 million/4 years

Three Years of
Trials : 2011-2013:

SCRI Agronomic Trials:
2013
-More promising NFPT
entries

“Fast-Track” Seed to
Allow for Commercial
Evaluations

NFPT Trial Sites, Fry Processing Sites, and Agronomic Trials

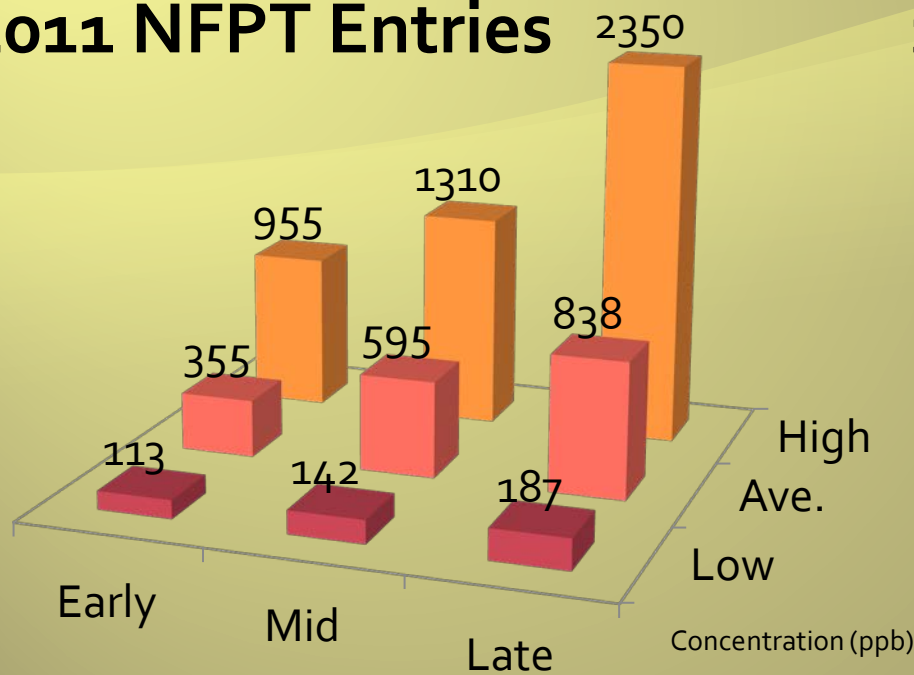


Background on NFPT

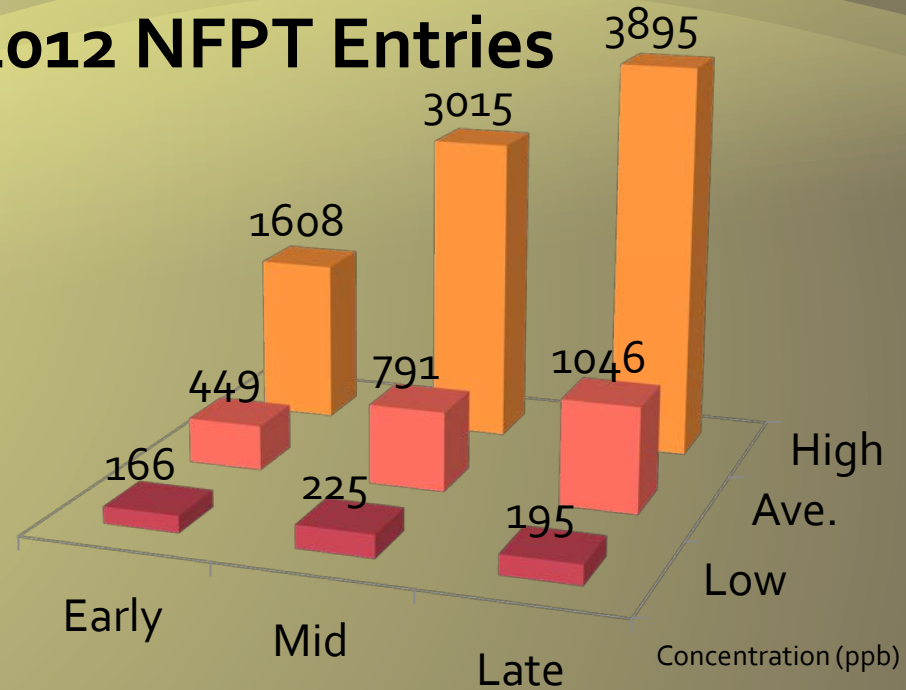
- ◆ Breeding clone and recent varieties: Unreplicated plots
- ◆ Russet Burbank and Ranger Russet: Standards
 - Umatilla Russet added in 2012
- ◆ Field notes:
 - Plant emergence and size
 - Vine maturity
 - Disease ratings: e.g. EB & VW
- ◆ Harvest and grading of trial plot for collection of data
 - Specific gravity
 - Tuber size distribution and culls
 - Tuber shape
 - Tuber internal and external defect notes
 - Breeder merit and tuber appearance ratings
- ◆ Tubers to E. Grand Forks Potato Research Worksite
 - Early processing, then Mid and Late from storage at 48° F
 - Acrylamide and Sugars (3x); Asparagine (2x)

Acrylamide Concentrations

2011 NFPT Entries

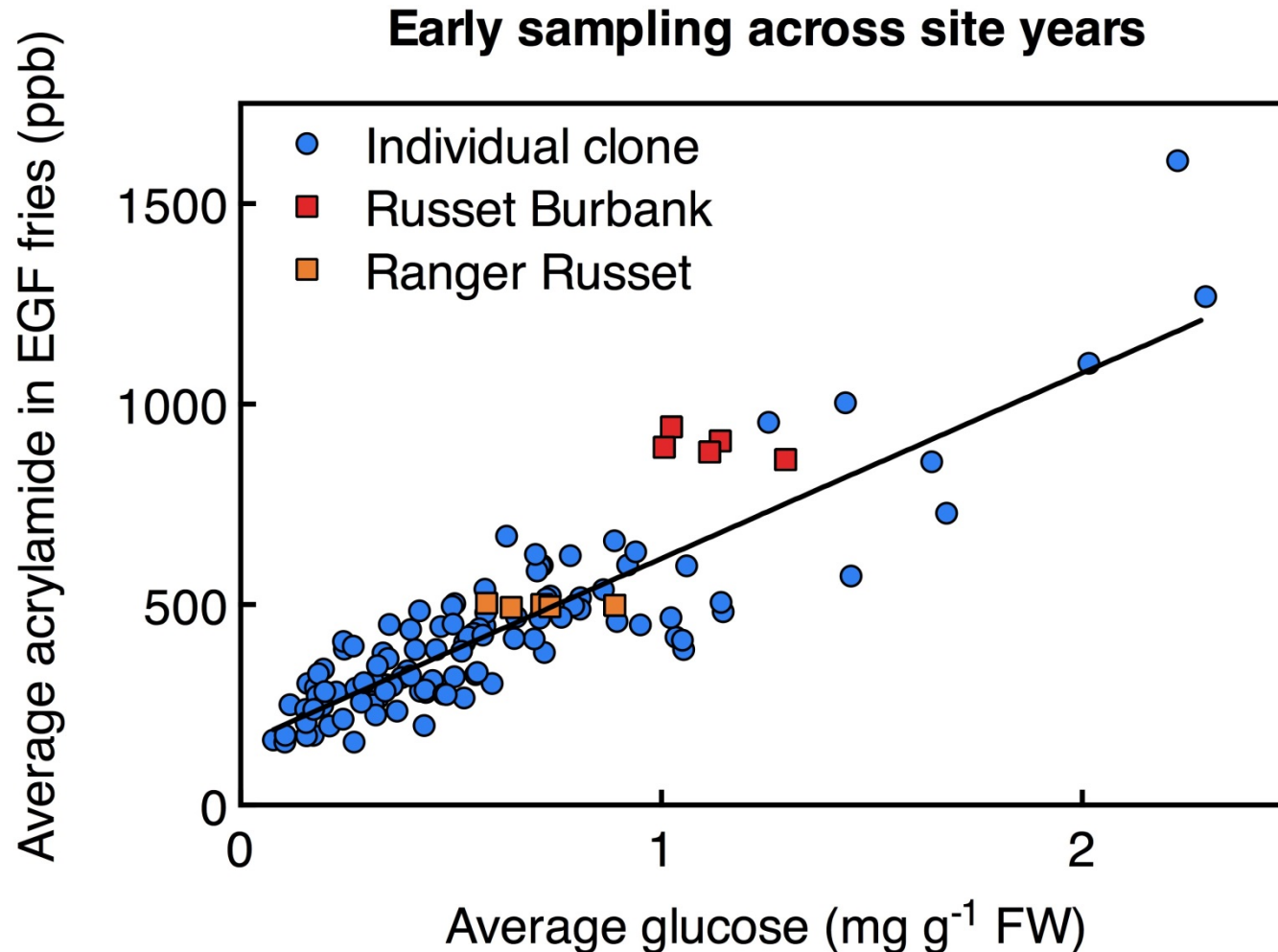


2012 NFPT Entries

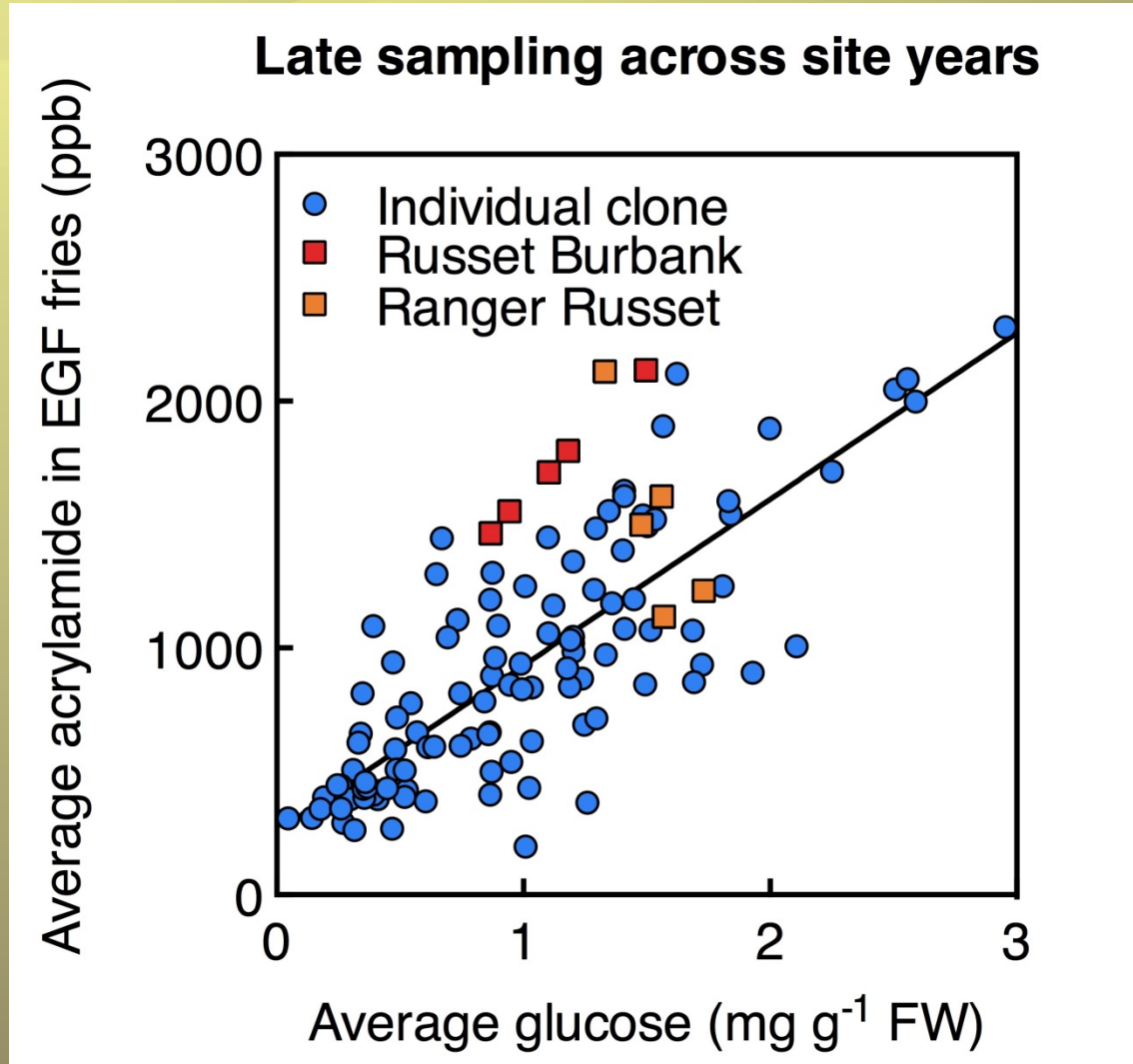


- ✓ Low and high acrylamide entries identified having relatively consistent rankings across all sites
- ✓ Trend for increasing acrylamide concentration with increased duration of storage
- ✓ Majority of breeding clones had lower acrylamide than Burbank/Ranger

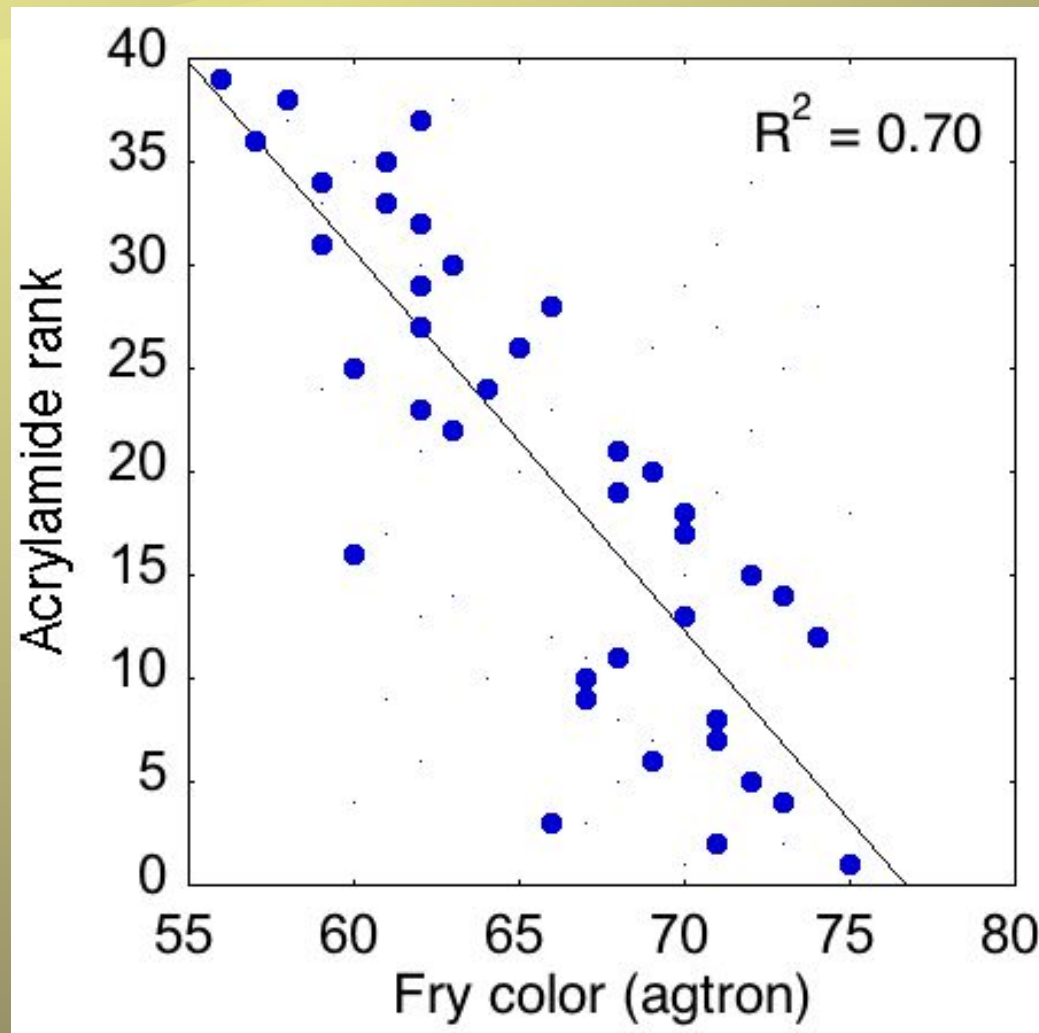
Acrylamide Correlates with Glucose...



....But, Weaker Association with Longer Storage

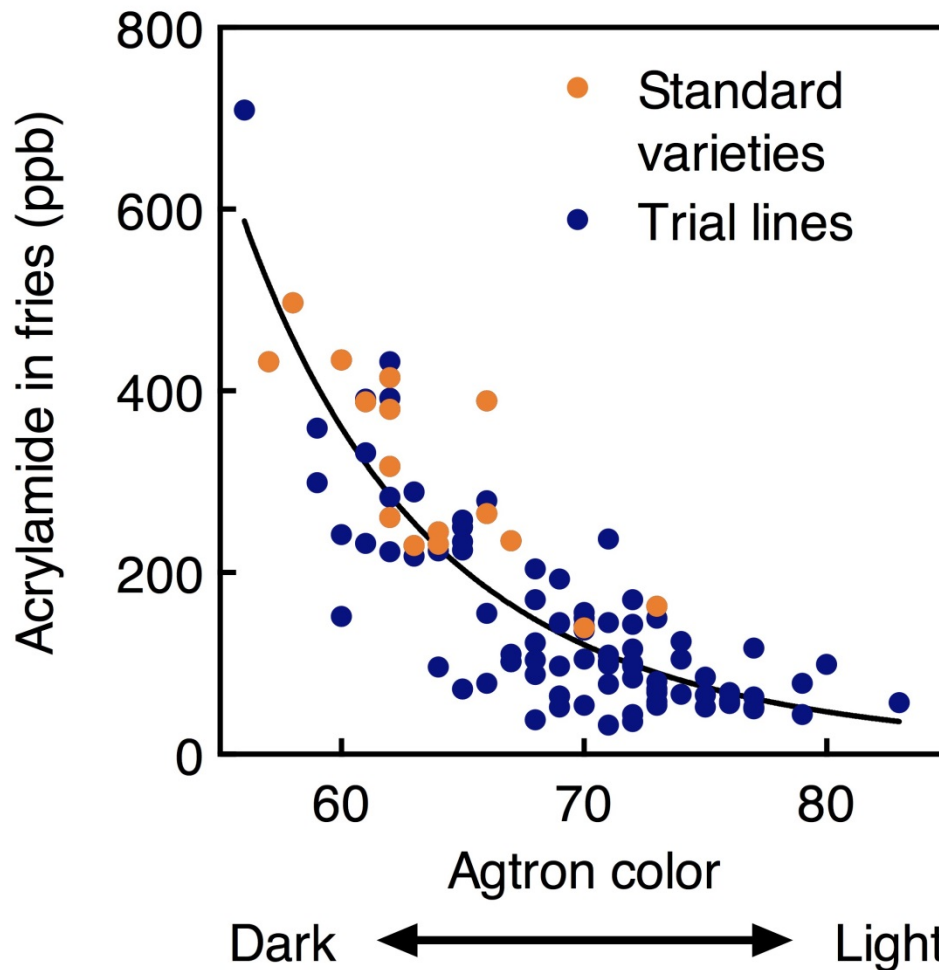


Fry color is a good predictor of acrylamide rank



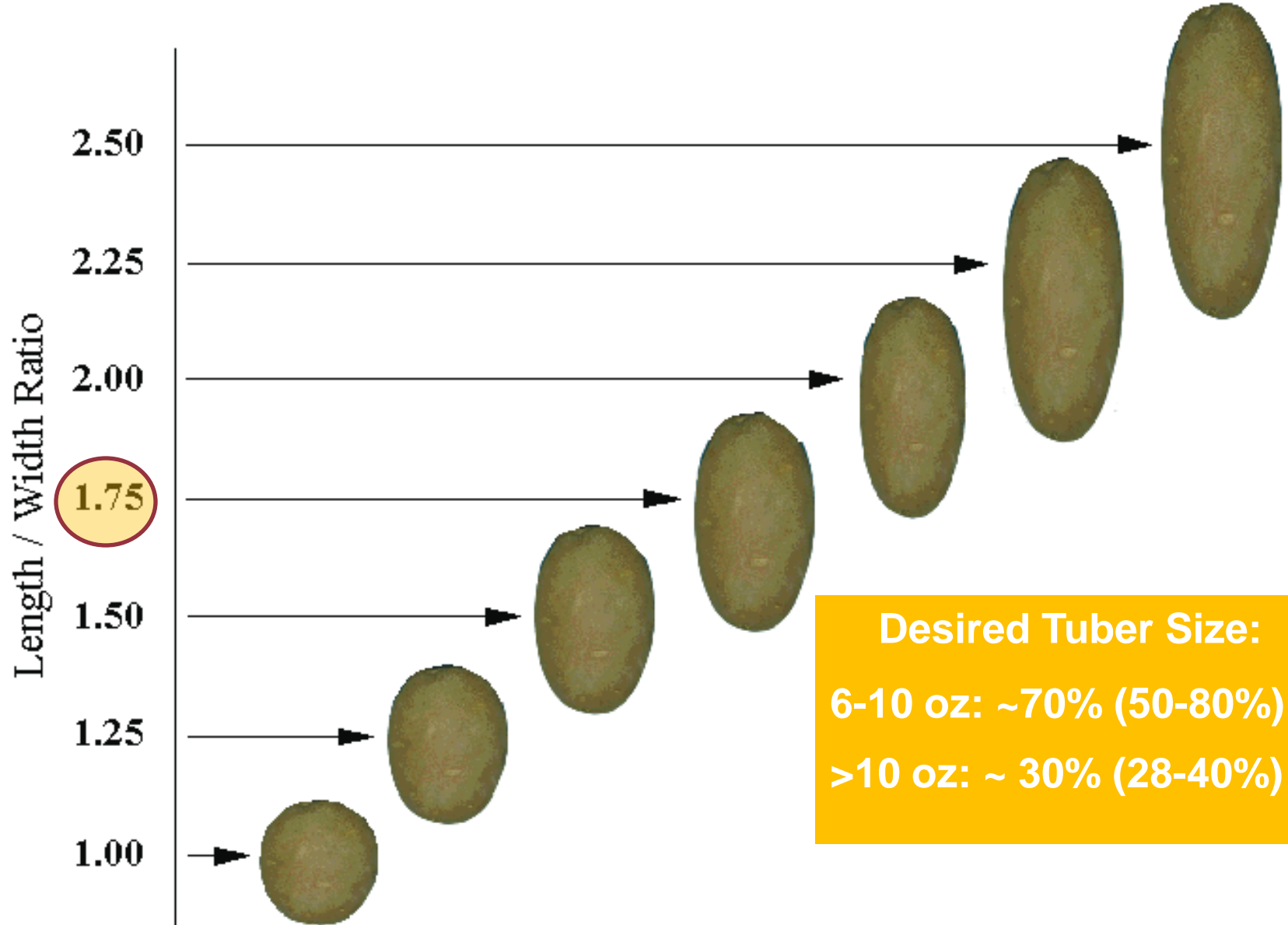
Source: NFPT

Many clones have excellent fry color and low acrylamide-forming potential



Source: NFPT

Additional Attributes of Processing Varieties



QSR French Fry Evaluations

Beginning in 2012:

- ✓ Samples Laid out: E. Grand Forks, MN
- ✓ Selection among plots for agronomic merit

Tubers samples also sent to:

- ✓ Simplot: Caldwell, ID (WA, ID, ND)
- ✓ McCain: Florenceville, NB (WI and ME)

QSR Fry evaluations conducted

- ✓ Early (1-2 month storage) and Long Term Storage (8 month)
- ✓ Labor and time intensive to conduct which limits number of samples able to be evaluated
- ✓ Very important for variety acceptance by processing industry and QSRs



QSR French Fry Evaluations

Important to QSR's

- ✓ Customers' expectations met
- ✓ Quality assurance
- ✓ New varieties must meet French fry quality standards
- ✓ Russet Burbank the standard for comparison

Fry Characteristics

- ✓ Color
- ✓ Length
- ✓ Rigidity
- ✓ Texture
- ✓ Flavor
- ✓ Aroma
- ✓ After-taste

French Fry Sensory Evaluations

Trained Panel

- ✓ Flavor: 17 attributes
- ✓ Aroma: 11 attributes
- ✓ Texture: 8 attributes
- ✓ Total: 36 sensory attributes!

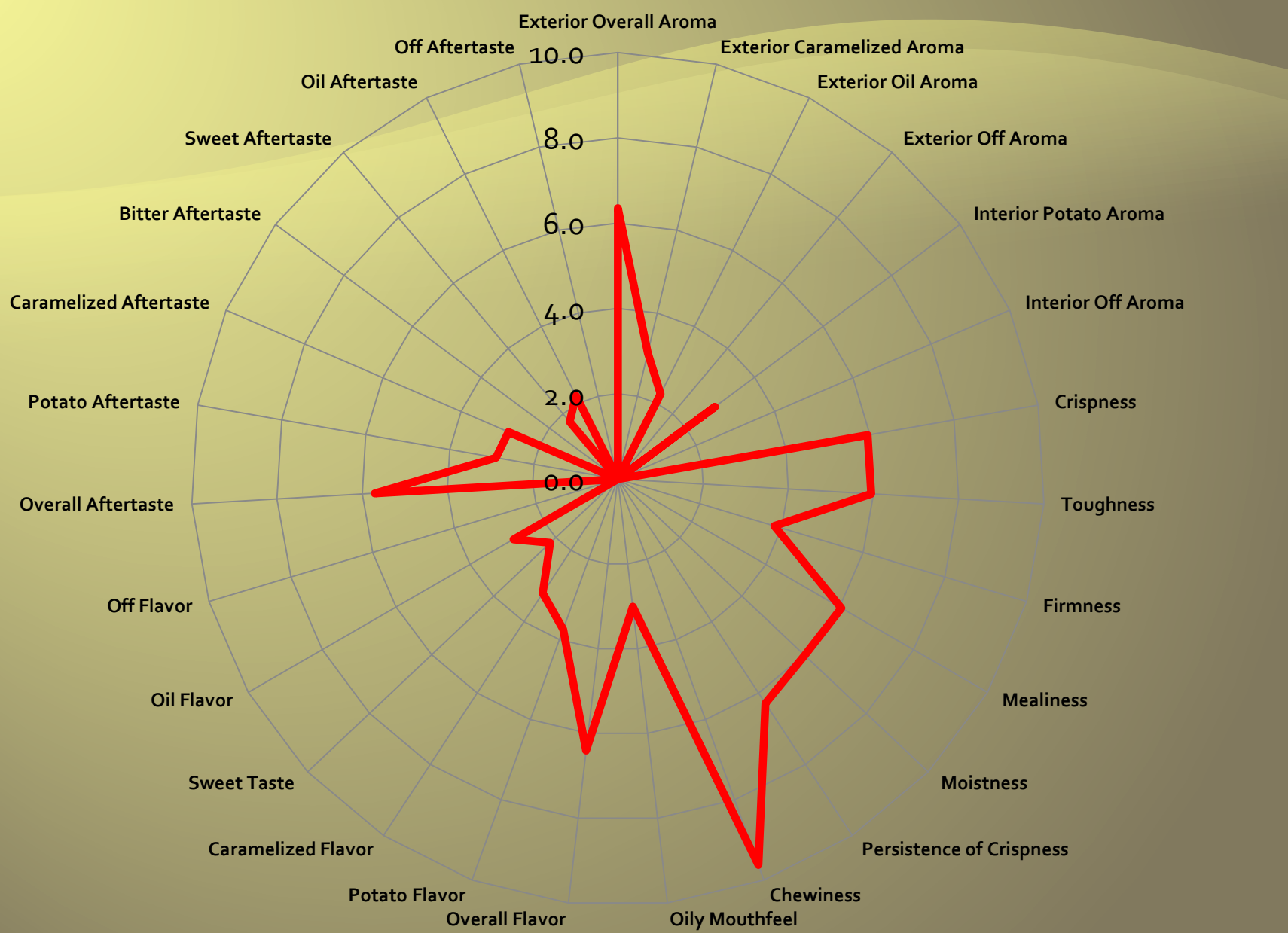
15 point scale as example:

0 = none
1 = barely detectable
2.5 = very slight
5.0 = slight
7.5 = slight to moderate
10.0 = moderate
12.5 = moderate to extreme
15.0 = extreme

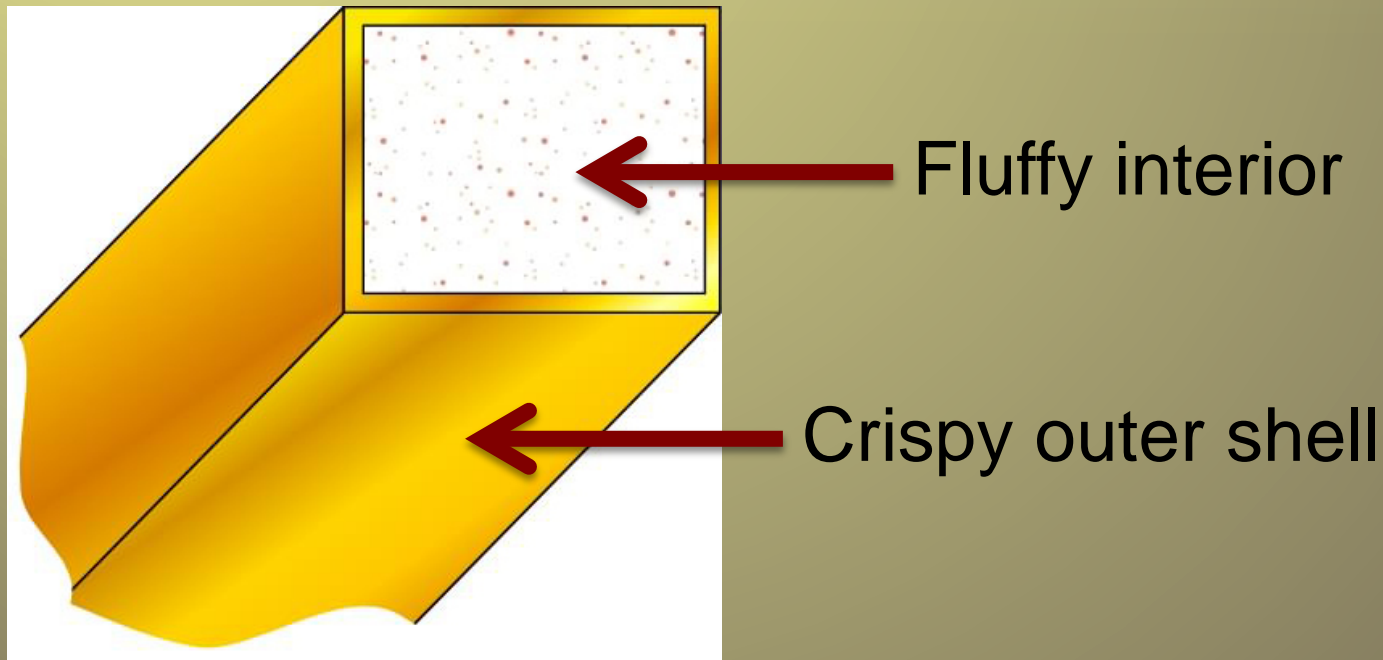
Comparisons with:

- ✓ Russet Burbank:
Approved by prior QA grading
- ✓ New varieties must consistently score comparable or better than Burbank
- ✓ Ultimate decision for acceptance of new variety from QSR customer

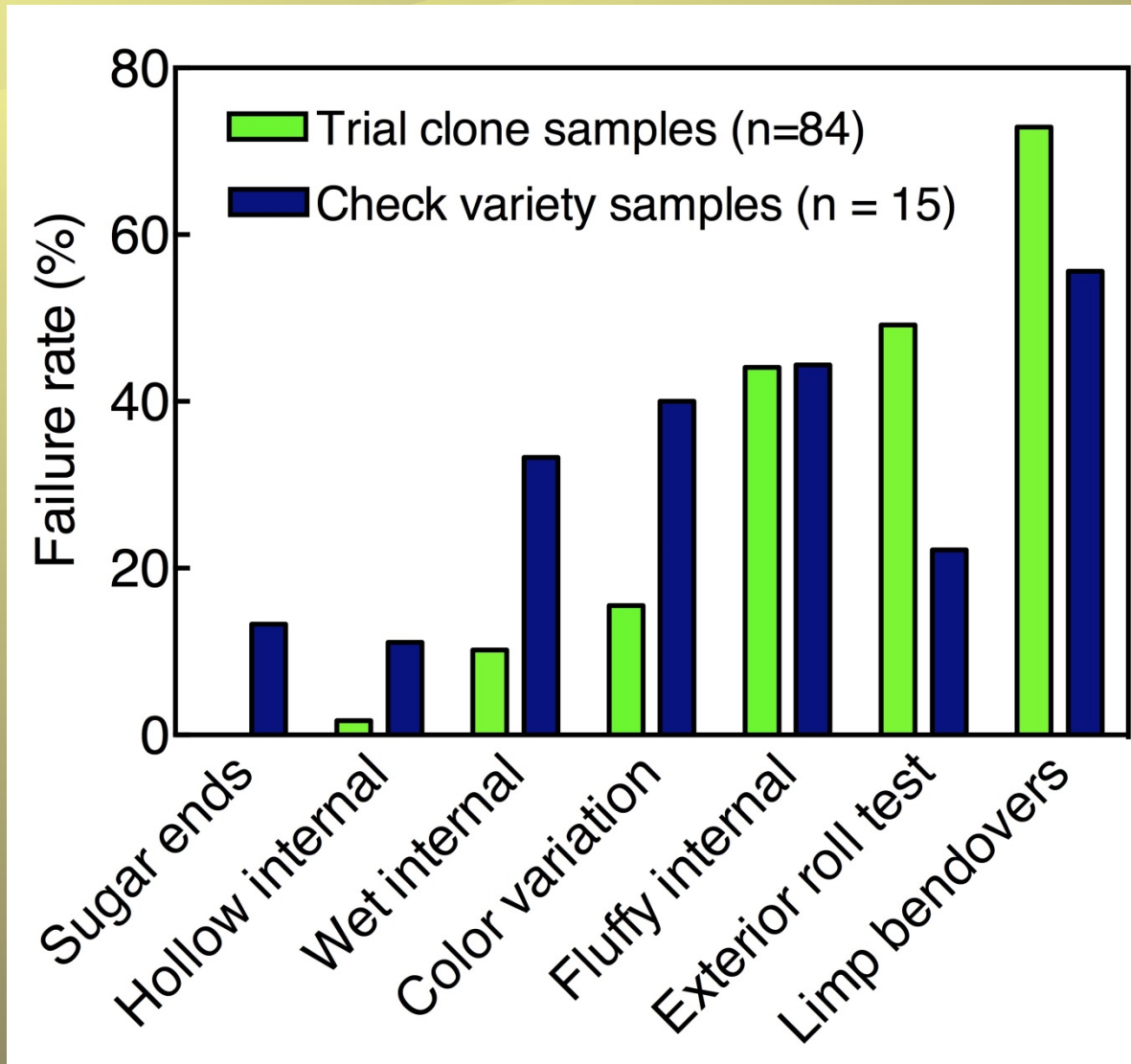
Typical Sensory Ratings: Burbank Shoe String Fries



FRY QUALITY SETS A HIGHER BAR FOR COMMERCIALIZATION THAN LOW ACRYLAMIDE



Failure rate of NFPT samples for select QSR processing criteria



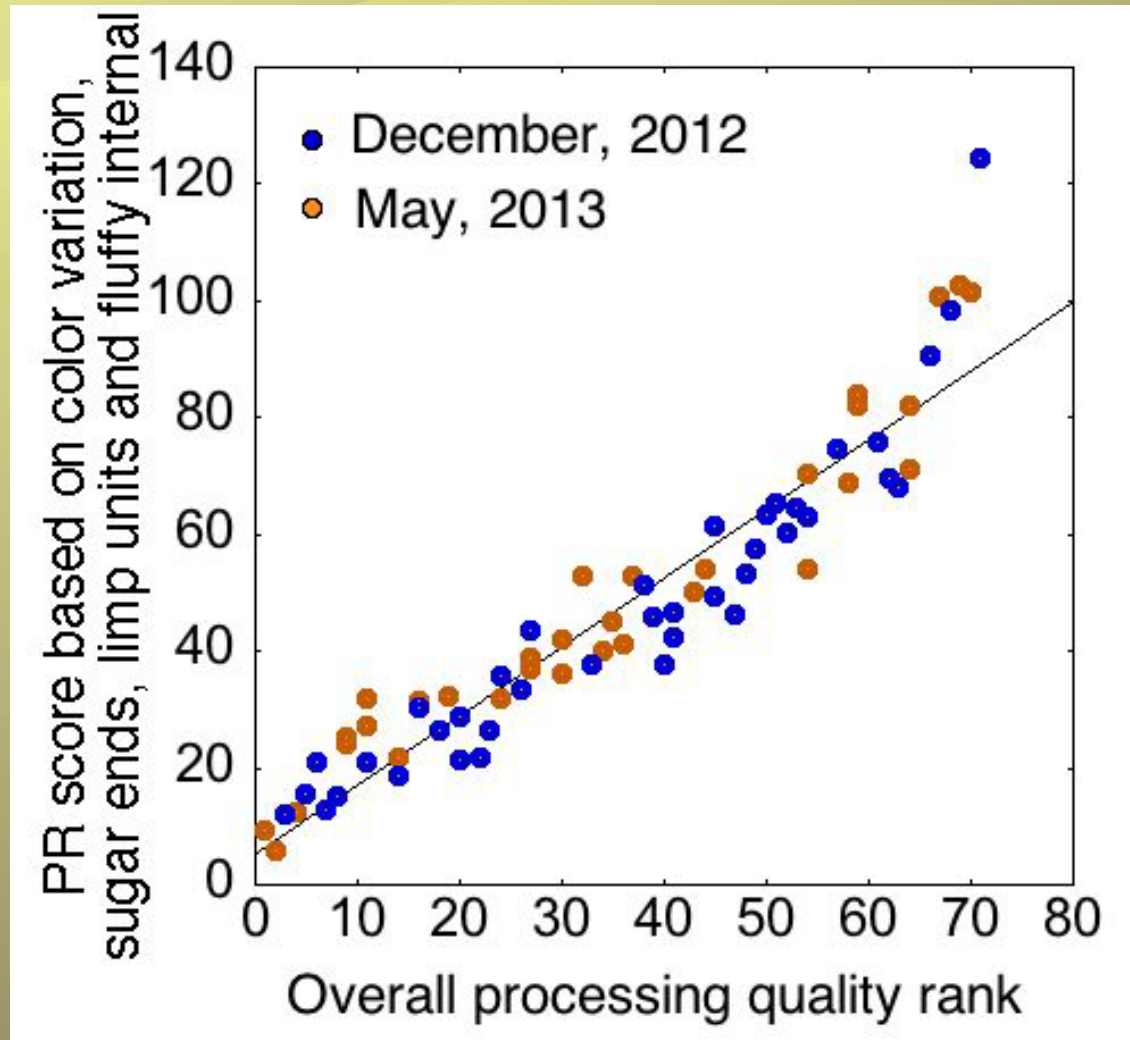
Source: NFPT

Can an estimate for fry processing quality be developed?

Incorporate processor and end-user criteria earlier in the decision making process:

- ✓ Which NFPT entries to advance
- ✓ Use by breeders earlier in the selection process—allowing the removal of clones having poorer fry sensory attributes
- ✓ Ideally would require minimal training and would make use of available facilities and personnel

A consumer attribute estimate based on easily scored French Fry characteristics



NFPT and SCRI Acrylamide Reduction Project: Objectives in the next 30 months

- ◆ Tissue culture cleanup
- ◆ Minituber production for virus-free seed
- ◆ Continued Trials
 - NFPT
 - SCRI Agronomic and Production Management
 - Commercial-scale (2015)
- ◆ Storage evaluation
 - Develop optimized storage management protocols
- ◆ Economic analyses
 - Value to the industry of low-acrylamide clones

Disease Free Tissue Culture Plantlets and Minituber Production

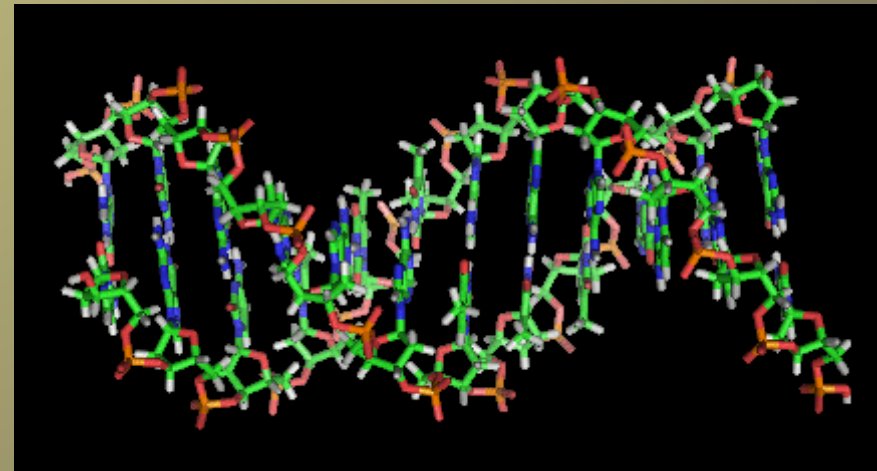
- ◆ “Clean up” 10 to 15 clones per year
- ◆ Produce minitubers of selected NFPT clones—begun last year for:
 - ◆ A02507-2LB, A02138-2, AF4296-3, Dakota Russet (ND8229-3), AC96052-1RU
 - ◆ Seed is available of W6234-4rus
- ◆ Grow first field generation seed in 2014
 - ◆ SCRI Agronomic trials and production management profiles leading to commercial-scale trials

SCRI Genetic Research:

- NFPT Comprehensive database has been developed
- Associate molecular markers with agronomic and processing traits to make breeding more efficient

AF3001-6

Yield, Specific gravity, Sugars			Acrylamide and asparagine		QSR evaluations		
Trial	Year	State	Breeder Merit	Tuber shape, flesh color	Total yield (lbs)		
					Clone	Burbank	Ranger
NFPT	2011	ID	marginal	long, white	72	73	90
NFPT	2011	ND	keep	long, white	80	89	80
NFPT	2011	WA	outstanding	round, white	147	128	125
NFPT	2012	ID	marginal	long, white	86	57	77
NFPT	2012	ND	keep	long, buff	77	79	75
NFPT	2012	WA	keep	oval, white	202	138	211
NFPT SCRI	2012	WI	keep	long	135	159	98
NFPT SCRI	2012	ME	outstanding	long, white	94	70	62



Progress to Date – Marker Development

- ◆ Mapping population
 - ◆ Grown in MI and ID
 - ◆ Cross of Premier Russet x Rio Grande Russet
 - ◆ Characterized using SNP molecular markers
- ◆ Processing data has been collected over years:
 - ◆ Sugars
 - ◆ Asparagine
 - ◆ Fry color
 - ◆ Acrylamide
- ◆ Use genetic marker data for each clone and its associated processing data to identify genes associated with desirable processing attributes
- ◆ Utilize for marker-assisted selection (MAS) to facilitate the development of low-acrylamide varieties with acceptable fry attributes

Summary: NFPT and SCRI Acrylamide Reduction Project

- Low acrylamide varieties/advanced breeding clones: Useful to the processing industry in meeting current CA acrylamide reduction mandates and possible future national mandates
- 140 breeding clones and 10 varieties have been evaluated through the NFPT trial over 3 years
- 50% of clones display lower reducing sugar and acrylamide levels than Russet Burbank and Ranger Russet
- Reducing sugar levels are strongly associated with acrylamide, but association weakens with prolonged storage

Summary Continued: NFPT and SCRI Acrylamide Reduction Project

- Weak association between asparagine and acrylamide formation
- Variability of clone performance across NFPT sites, years, and management systems—not unexpected but “one size fits all” may be difficult to achieve
- Meeting QSR French Fry processing parameters is proving a larger hurdle to overcome in acceptance of breeding clones by industry than is lowered acrylamide
 - ✓ Low acrylamide formation \neq industry acceptance

*SCRI acrylamide reduction website can be found at:
<http://acrylamide.vegetables.wisc.edu/>*

Thanks to many people...

The breeders, agronomists, and researchers that contribute to the NFPT and SCRI acrylamide reduction project. Special thanks to A.J. Bussan, Paul Bethke, and Yi Wang for sharing of slides

The fry processing companies, USPB, state potato commissions, QSRs, and growers that have contributed funding, expertise and essential data

ALS Consulting-David Parish and Paul Voglewede

The USDA NIFA SCRI for funding research on acrylamide reduction



THANK YOU. QUESTIONS?